Islamic University of Gaza

Faculty of Engineering
Electrical Engineering Department
Fall-2011

Communication II Lab (EELE 4170)

Lab#1 Line Code Encoder

Objectives

1- To understand the theory and applications of line code encoder.
2- To understand the encode theory and circuit structure of NRZ.
3- To understand the encode theory and circuit structure of RZ.
4- To understand the encode theory and circuit structure of Manchester.

Theory

Line coding is a part of source coding. Before PCM signal is send to modulator, we use certain signal mode in certain application. The considerations of selecting the digital signal modes to carry the binary data are: 1. types of modulation, 2. types of demodulation, 3. the limitation of bandwidth, and 4. Types of receiver.

Line coding can be divided into two types, which are return-to-zero (RZ) and nonreturn-to-zero (NRZ). RZ line coding denotes for a single bit time (normally is half of a signal bit time), the waveform will return to 0 V between data pulses. The data stream is shown in figure 1-1(c). NRZ line coding denotes for a single bit time, the waveform will not return to 0 V. The data stream is shown in figure 1- 1(a).

As a result of the characteristics of signal, line coding also can be divided into two types, which are unipolar signal and bipolar signal. Unipolar signal denotes that the signal amplitude varies between a positive voltage level which are +V and 0 V. The only different between bipolar signal and unipolar signal is the signal amplitude varies between a positive and a negative voltage level which are +V and -V. Figure 1-1 shows different types of line code signals and we will discuss the encoding signals in next section.

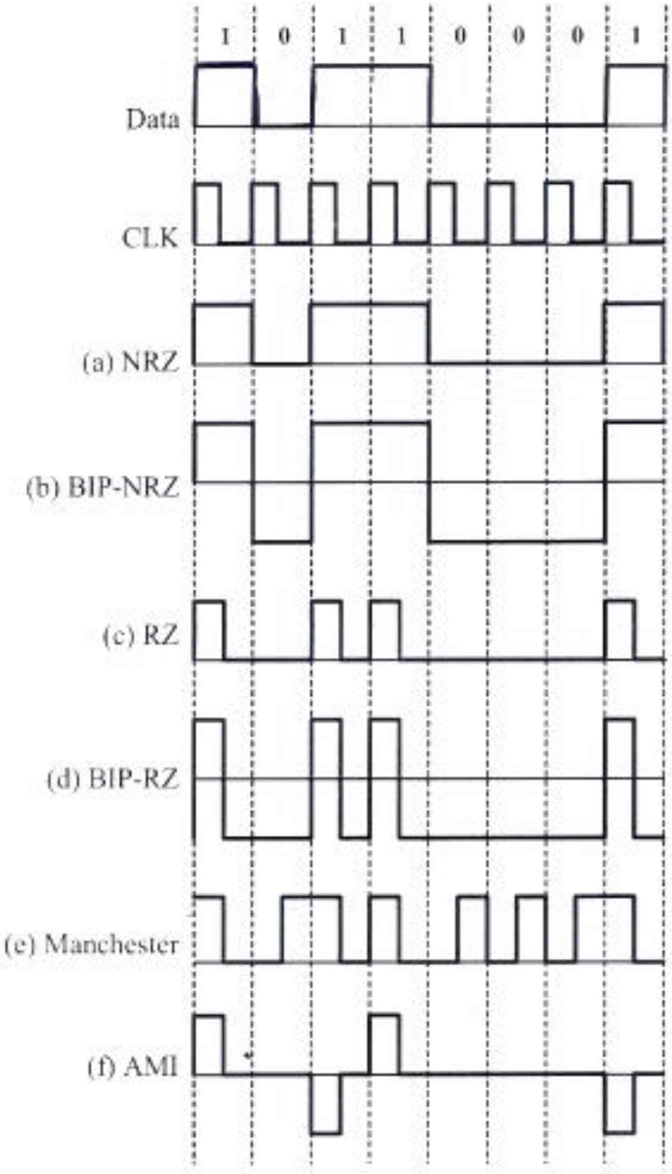


Figure 1-1 Different types of line code signal waveforms

1. UNIPOLAR NONRETURN-TO-ZERO SIGNAL ENCODE

The data stream of unipolar nonreturn-to-zero (UNI-NRZ) is shown in *figure 1-1(a)*. From figure 1-1(a), when the data bit is “1”, the width and the gap between bits of UNI-NRZ are equal to each others; when the data bit is “0”, then the pulse is represented as 0 V. The circuit diagram of UNI-NRZ encoder is shown in figure 1-2. As a result of the data signal and the NRZ encoder signal are similar, therefore, we only need to add a buffer in front of the circuit.

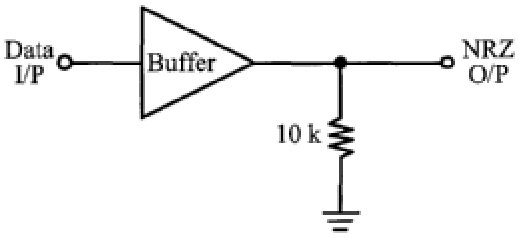


Figure 1-2 Circuit diagram of unipolar nonreturn-to-zero encoder.

2. BIPOLAR NONRETURN-TO-ZERO SIGNAL ENCODE

The data stream of bipolar nonreturn-to-zero (BIP-NRZ) is shown in *figure 1-1(b)* When the data bit of BTP-NRZ is "1" or "0", the signal amplitude will be a positive or a negative voltage level. As for bit time, no matter the data bit is "1" or "0", the voltage level remain same. Figure 1-3 is the circuit diagram of BIP-NRZ encoder. By comparing the data streams of UNI-NRZ and BLP-NRZ, the only difference is the signal amplitude is a negative voltage level when the data bit is "0", therefore, we may utilize a comparator to encode the data bit in the circuit.

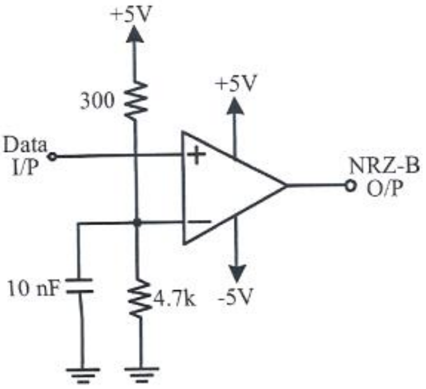


Figure 1-3 Circuit diagram of bipolar nonreturn-to-zero encoder.

3. UNIPOLAR RETURN-TO-ZERO SIGNAL ENCODE

The data stream of unipolar return-to-zero (IJNI-RZ) is shown in *figure 1-1(c)*. When the data bit is "1", the signals amplitude at 1/2 bit time is positive voltage level and the rest of the bit time is represented as 0 V. When the data bit is "0", there is no pulse wave that means the signal amplitude is 0 V. The bit time of RZ is half of the bit time of NRZ, therefore, the required bandwidth of RZ is one time more than NRZ. However, RZ has two phase variations in a bit time, which is easy for receiver synchronization. From figure 1-1, compare the data signal, clock signal and data after encoding, we know that in order to obtain the encoding data of RZ, we need to "AND" the data signal and clock signal. The circuit diagram of unipolar return-to-zero encoder is shown in figure 1-4.

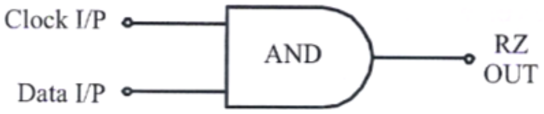


Figure 1-4 Circuit diagram of unipolar return-to-zero encoder.

4. BIPOLAR RETURN-TO-ZERO SIGNAL ENCODE

The data stream of bipolar return-to-zero (BIP-RZ) is shown in *figure 1-1(d)*. When the data bit is "1", the signal amplitude at 1/2 bit time is positive voltage level and the other 1/2 bit time is negative voltage level. When the data bit is "0", the signal amplitude of the bit time is represented as negative voltage level. Figure 1-5 is the circuit diagram of BIP-RZ. By comparing the data streams of RZ and BIP-RZ in figure 1-1, we only need a converter to convert the encoding signal from unipolar to bipolar, therefore, we utilize a comparator to design the converter, which can convert the RZ to BIP-RZ signal.

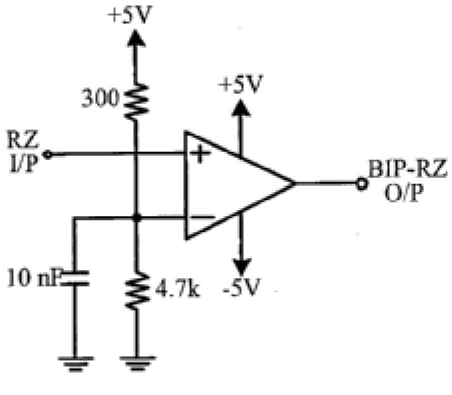


Figure 1-5 Circuit diagram of bipolar return-to-zero encoder.

6. MANCHESTER SIGNAL ENCODE

Manchester signal is also known as split-phase signal. The data stream of Manchester signal is shown in *figure 1-1(e)*. When the data bit is “1”, the signal amplitude at first 1/2 bit time is positive voltage level and the other 1/2 bit time is negative voltage level. When the data bit is “0”, the signal amplitude at first 1/2 bit time is negative voltage level and the other 1/2 bit time is positive voltage level. This type of encode signal has the advantage of memory, therefore, the required bandwidth is larger than the other encode signals. So, it is suitable applied to network such as Ethernet. From figure 1-1, compare the data signal, clock signal and data after encoding, we know that in order to obtain the encoding data of Manchester, we need to “XNOR” the data signal and clock signal. Figure 1-6 is the circuit diagram of Manchester signal encoder.

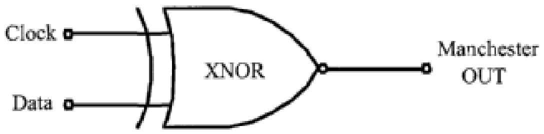


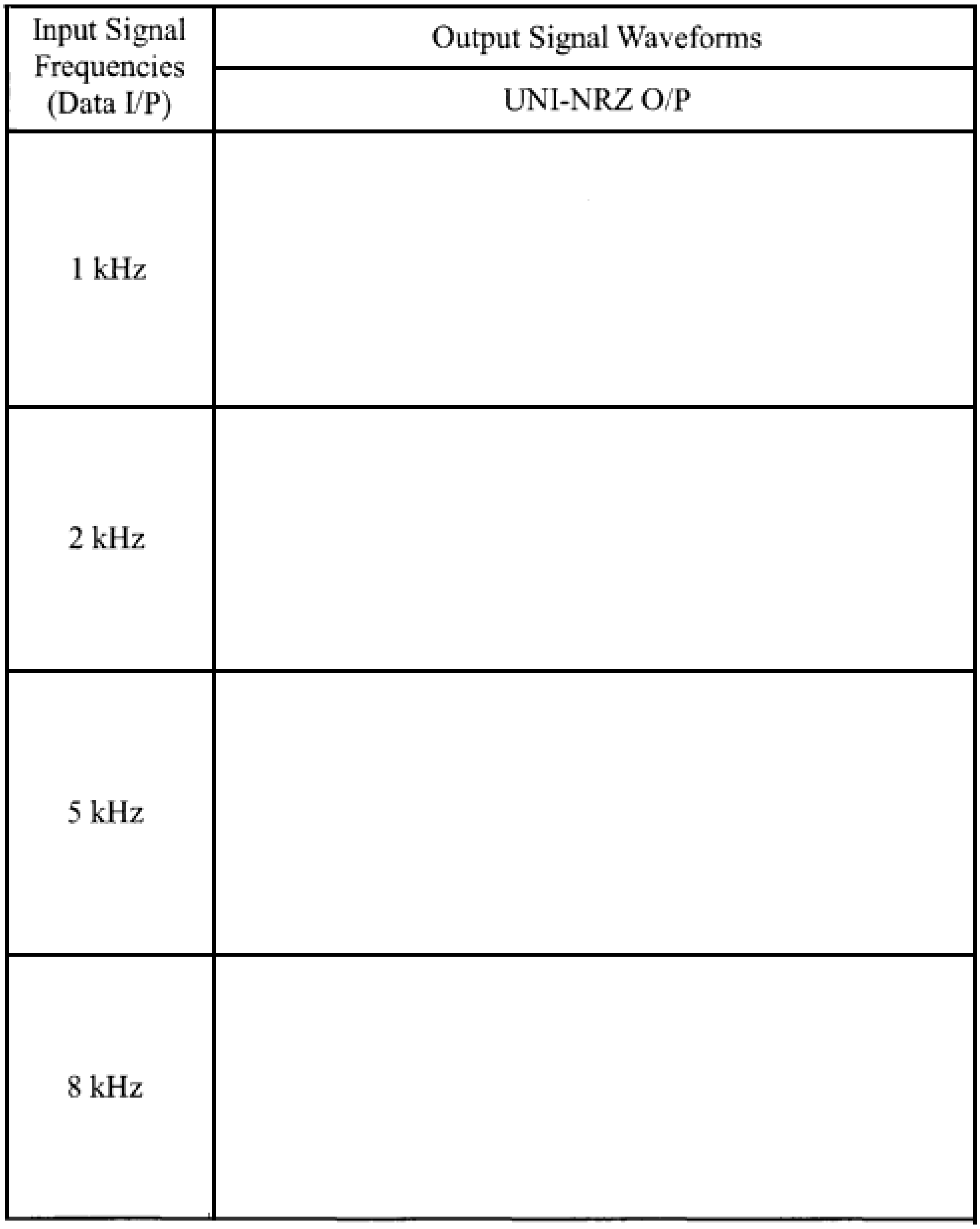
Figure 1-6 Circuit diagram of Manchester signal encoder.

Experiment Items

PART 1: UNIPOLAR AND BIPOLAR NRZ SIGNAL ENCODE

1-1: Unipolar NRZ signal encode

1) To implement a unipolar NRZ encode circuit as shown in figure 1-2 or refer to figure DCS1-1 on ETEK DCS-6000-01 module.
2) Setting the frequency of function generator to 1 kHz TTL signal and connect this signal to the Data I/P. Then observe on the output waveform by using oscilloscope and record the measured results in table 1-1.
3) According to the input signals in table 1-1, repeat step 2 and record the measured results in table 1-1.

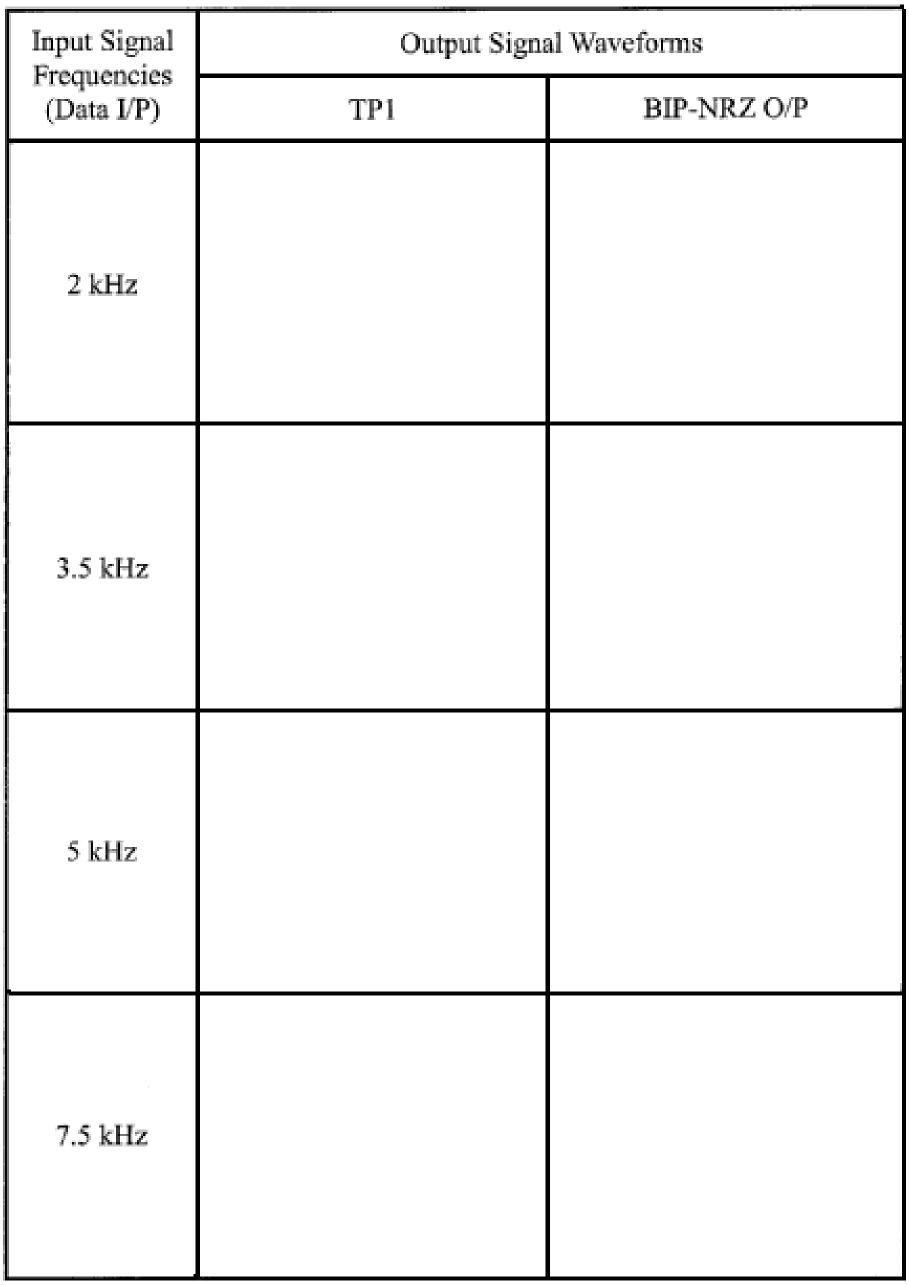


Input Signal Frequencies (Data I/P)	Output Signal Waveforms
	UNI-NRZ O/P
1 kHz	
2 kHz	
5 kHz	
8 kHz	

Table 1-1 Measured results of UNI-NR.Z signal encode.

1-2: Bipolar NRZ signal encode

1) To implement a bipolar NRZ signal encode circuit as shown in figure 1-3 or refer to figure DCS1-1 on ETEK DCS-6000-01 module.
2) Setting the frequency of function generator to 1 kHz TTL signal and connect this signal to the Data TIP. Then observe on the waveforms of TP1 and BLP-NRZ 0/P by using oscilloscope and record the measured results in table 1-2.
3) According to the input signals in table 1-2, repeat step 2 and record the measured results in table 1-2.



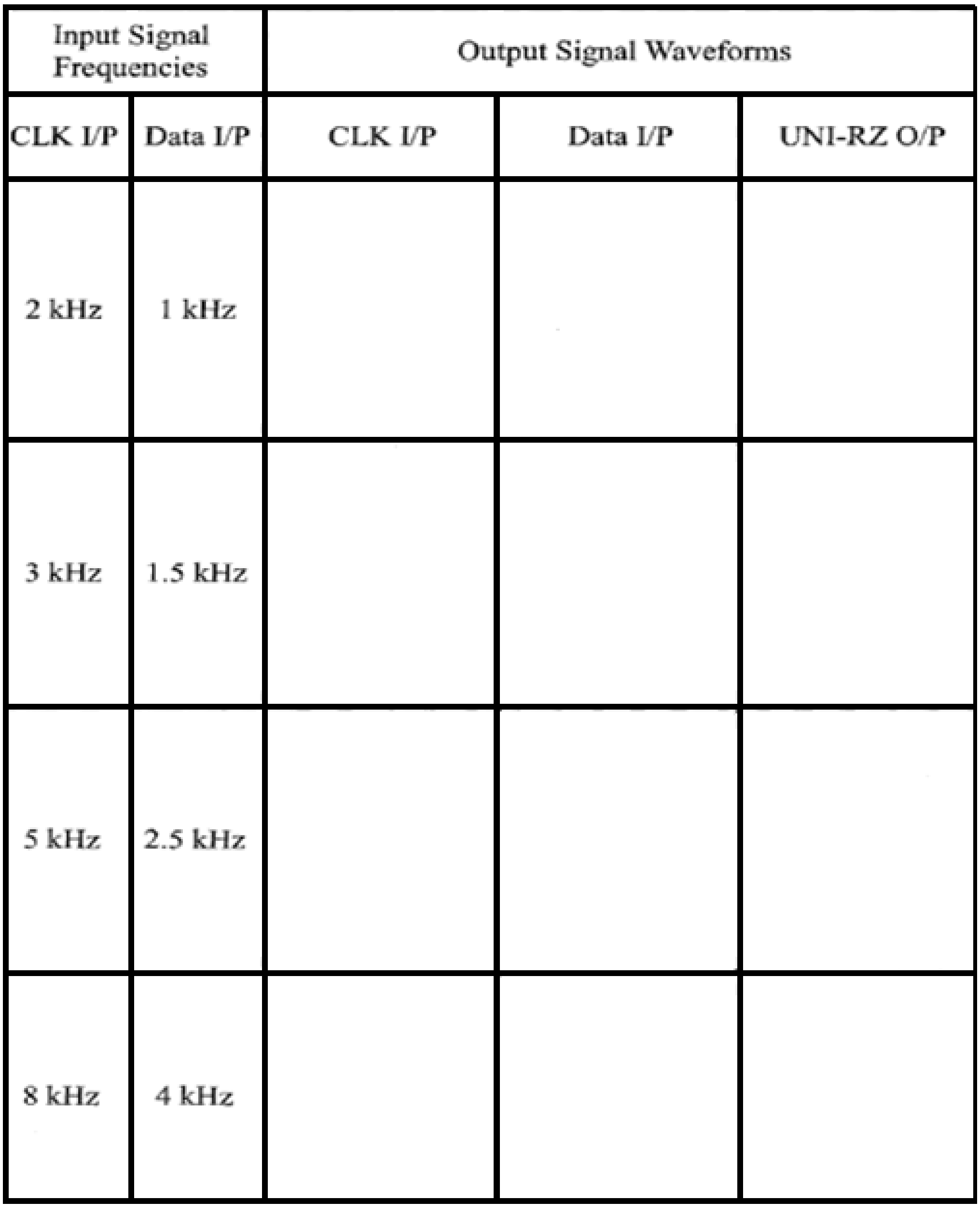
Input Signal Frequencies (Data I/P)	Output Signal Waveforms	
	TP1	BIP-NRZ O/P
2 kHz		
3.5 kHz		
5 kHz		
7.5 kHz		

Table 1-2 Measured results of BIP-NRZ signal encode.

PART 2: UNIPOLAR AND BIPOLAR RZ SIGNAL ENCODE

2-1: Unipolar RZ signal encode

1) To implement a unipolar RZ signal encode circuit as shown in figure 1-4 or refer to figure DCS 1-2 on ETEK DCS-6000-01 module.
2) Setting the frequency of function generator to 2 kHz TTL signal and connect this signal to the CLK I/P in figure DCS1-2. Then setting another frequency of function generator to 1 kHz TTL signal and connect this signal to the Data UP in figure DCS1-2. Then observe on the waveforms of CLK UP, Data UP and UNI-RZ 0/P by using oscilloscope, and record the measured results in table 1-3.
3) According to the input signals in table 1-3, repeat step 2 and record the measured results in table 1-3.

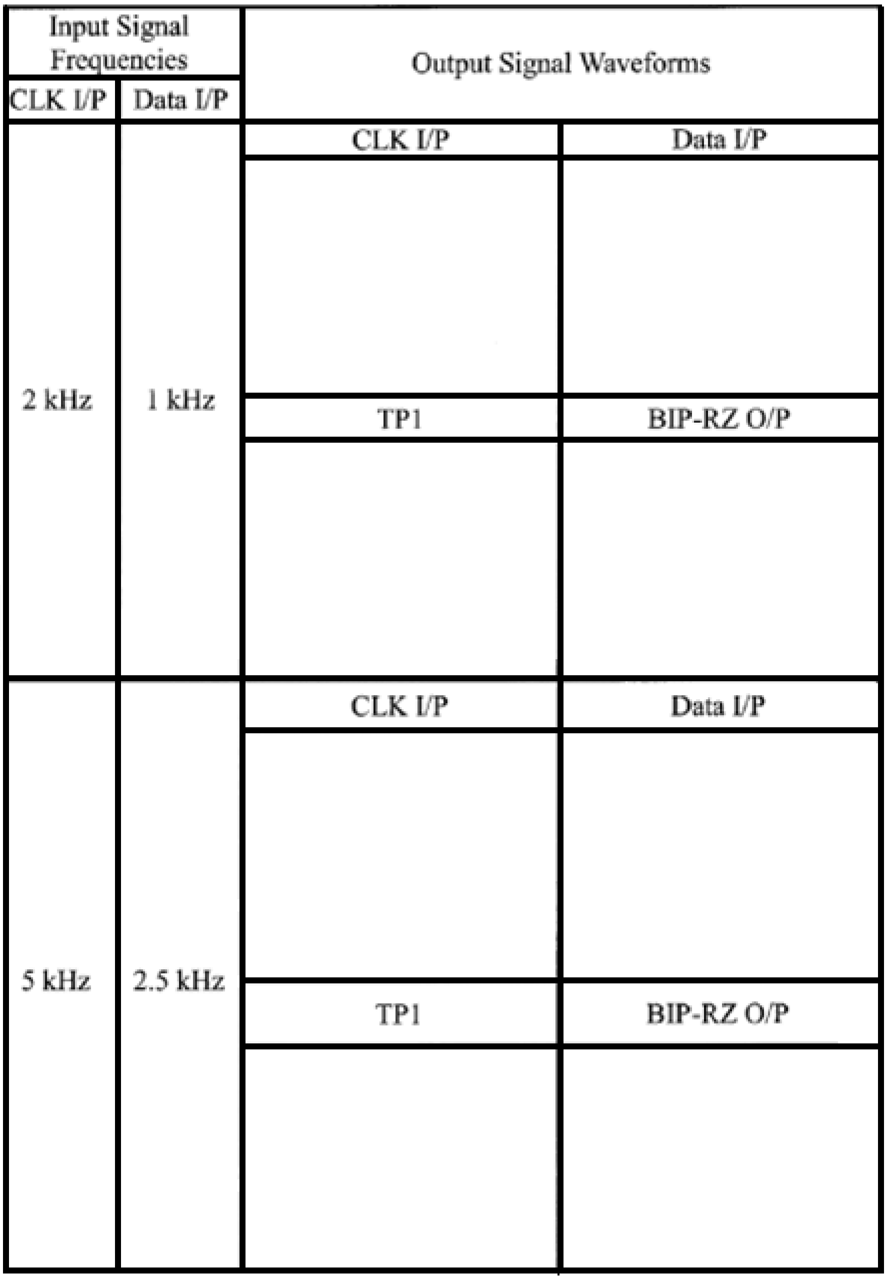


Input Signal Frequencies		Output Signal Waveforms		
CLK I/P	Data I/P	CLK I/P	Data I/P	UNI-RZ O/P
2 kHz	1 kHz			
3 kHz	1.5 kHz			
5 kHz	2.5 kHz			
8 kHz	4 kHz			

Table 1-3 Measured results of UNI-RZ signal encode.

2-2: Bipolar RZ signal encode

1) To implement a bipolar RZ signal encode circuit as shown in figure 1.5 or refer to figure DCS1-2 on ETEK DCS-6000-01 module.
2) Setting the frequency of function generator to 2 kHz TTL signal and connect this signal to the CLK I/P in figure DCS 1-2. Then setting another frequency of function generator to 1 kHz TTL signal and connect this signal to the Data I/P in figure DCS1-2. Then observe on the waveforms of CLK I/P, Data I/P, TP1 and BIP-RZ 0/P by using oscilloscope, and record the measured results in table 1-4.
3) According to the input signals in table 1-4, repeat step 2 and record the measured results in table 1-4.

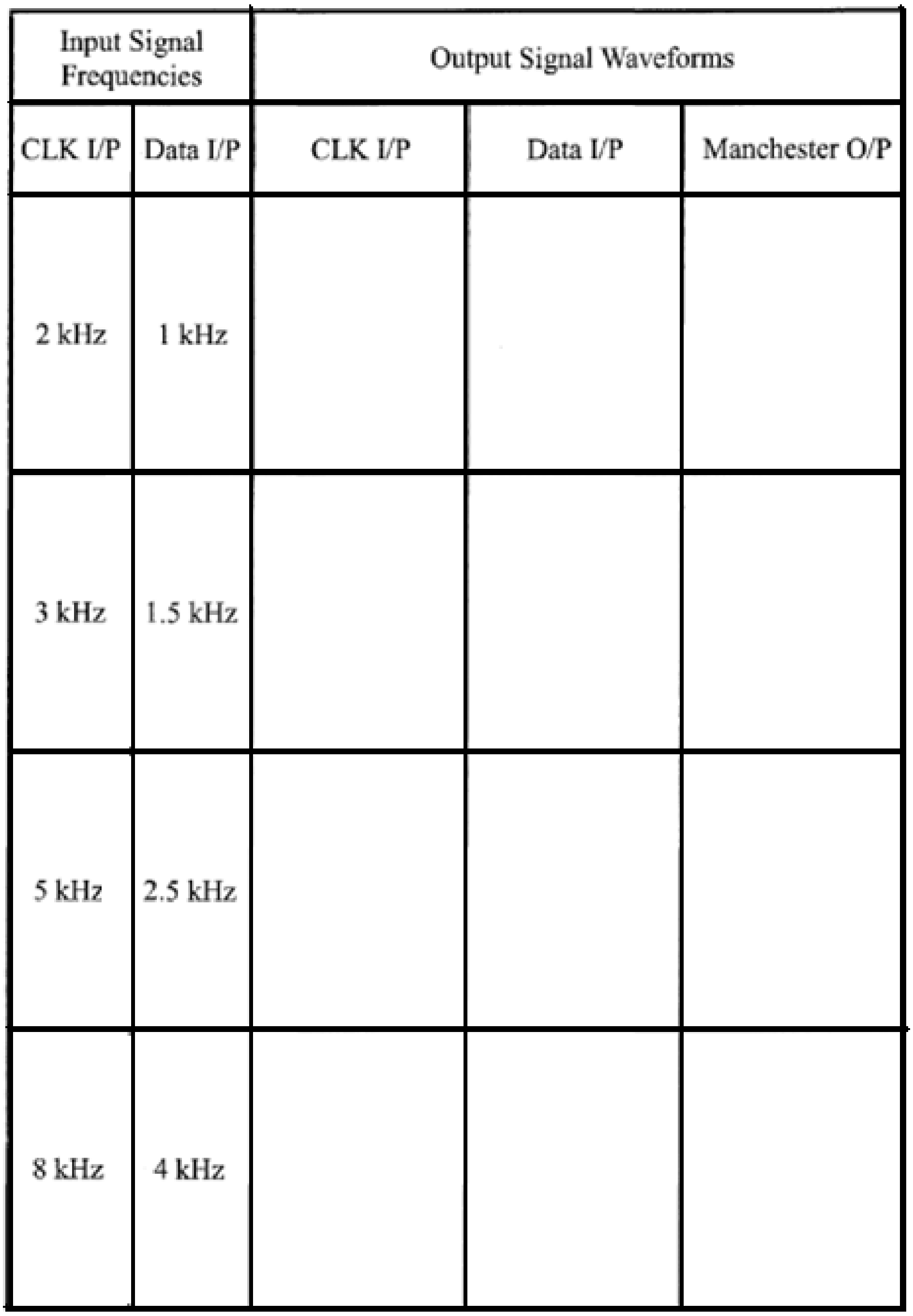


Input Signal Frequencies		Output Signal Waveforms	
CLK I/P	Data I/P		
2 kHz	1 kHz	CLK I/P	Data I/P
		TP1	BIP-RZ O/P
5 kHz	2.5 kHz	CLK I/P	Data I/P
		TP1	BIP-RZ O/P

Table 1-4 Measured results of BIP-RZ signal encode.

EXPERIMENT 4: MANCHESTER SIGNAL ENCODE

1) To implement a Manchester signal encode circuit as shown in figure 1-6 or refer to figure DCS1-4 on ETEK DCS-6000-01 module.
2) Setting the frequency of function generator to 2 kHz TTL signal and connect this signal to the CLK L/P in figure DCS1-4. Then setting another frequency of function generator to 1 kHz TTL signal and connect this signal to the Data I/P in figure DCS1-4. Then observe on the waveforms of CLK I/P, Data I/P and Manchester O/P by using oscilloscope, and record the measured results in table 1-5.
3) According to the input signals in table 1-5, repeat step 2 and record the measured results in table 1-5.

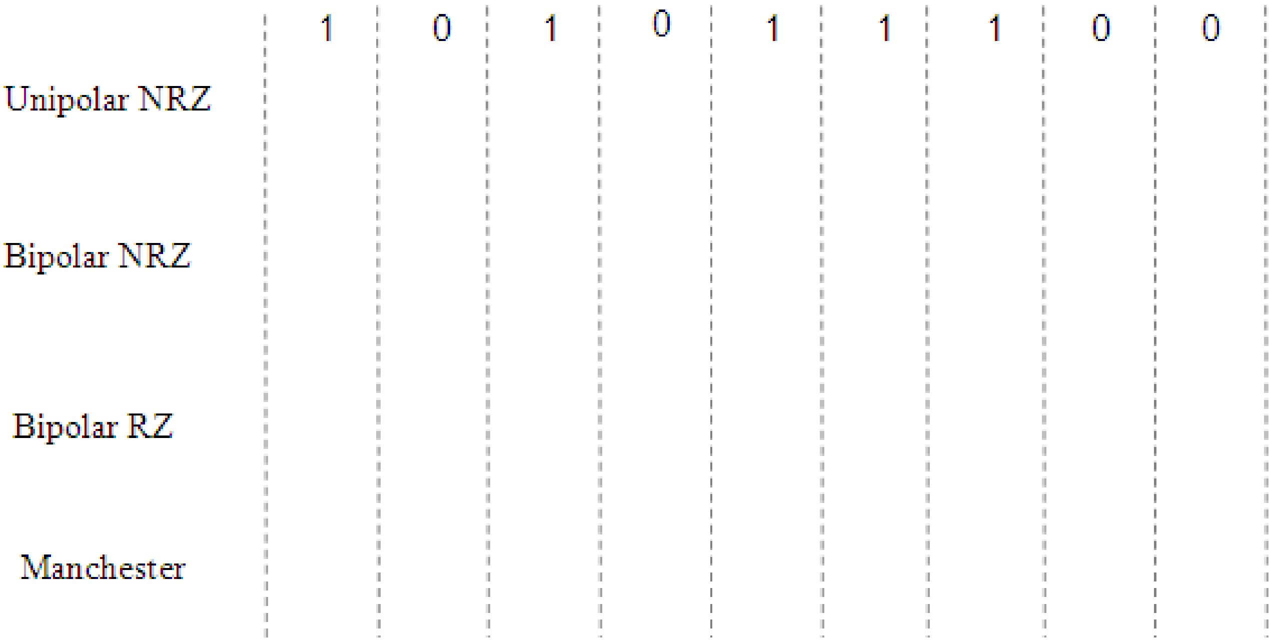


Input Signal Frequencies		Output Signal Waveforms		
CLK I/P	Data I/P	CLK I/P	Data I/P	Manchester O/P
2 kHz	1 kHz			
3 kHz	1.5 kHz			
5 kHz	2.5 kHz			
8 kHz	4 kHz			

Table 1-5 Measured results of Manchester signal encode.

Exercise 1

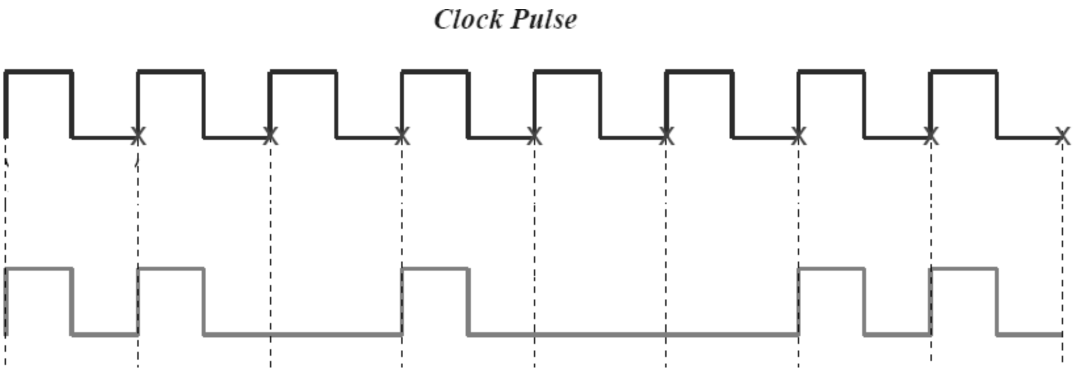
Encode the following bit stream



Exercise 2

What is the binary number encodes in the PCM waveform shown below?

What is the type of this waveform?



Exercise 3

Use the DCS1 Line Code Encoder module to implement a New signal encode circuit